UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Observing Systems Council
Silver Spring, MD 20910

June 13, 2007

MEMORANDUM FOR: NOAA Program Management Council

FROM: NOAA Observing Systems Council

SUBJECT: Program Management Council Action Item #23: Describing the Practical Applications That Were Lost by Removing the Hyperspectral Environmental Suite from the Geostationary Operational Environmental Satellite Series R

On September 28, 2006, the National Oceanic and Atmospheric Administration (NOAA) Program Management Council (PMC) assigned the subject action item to the NOAA Observing Systems Council (NOSC). On February 28, 2007, the NOSC reported that the National Environmental Satellite, Data, and Information Service (NESDIS) was performing an Analysis of Alternatives (AoA) to address the two primary functions of the Hyperspectral Environmental Suite (HES). The NOSC response to the action item, taking into consideration the AoA recommendations, is broken into two separate parts: Action Item #23a and Action Item #23b.

Action Item 23a. – *What are the practical applications that will be lost by the removal of the HES Advanced Sounding capability?*

The applications lost by removing the HES from the Geostationary Operational Environmental Satellite Series R (GOES-R) are: (1) extending warning lead times for severe weather; (2) providing a 4-dimensional characterization of water vapor at the temporal and spatial scales, which are necessary to forecast individual thunderstorms; (3) detecting the evolution of low-level temperature inversions; and (4) observing the variations in surface emissivity, which are necessary for accurate temperature and moisture profiles and their rapid temporal evolution in the pre-storm environment.

Attachment 1A has further details on the lost applications and other alternatives explored due to the removal of the HES advanced sounding capability.

Action Item 23b. – *What are the practical applications that will be lost by the removal of HES Coastal Waters Imager capability?*

The applications lost by removing the HES from GOES-R are: (1) quantitative characterization of fundamental components of the Nation's estuaries for the first time; (2) a capability to predict and monitor the growth, spread, severity, and duration of Harmful Algal Blooms (HABs); (3) resolution of the tidal and diurnal components to HABs; (4) an input dataset for determining optimal NOAA research cruise tracks; (5) detection of changes that occur during severe

HAB-related mortality events of protected species; and (6) an ability to resolve HABs at a much higher spatial resolution than the present capability.

Attachment 1B has further details on the lost applications and other alternatives explored due to the removal of the HES Coastal Waters Imaging capability.

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Attachment 1.

Lost Applications and Other Alternatives Explored Due to the Removal of the GOES-R HES

A. Advanced Sounding Applications

The advanced sounding capability at the temporal, spatial, and vertical resolution planned for the HES instrument on GOES-R, coupled with the operational implementation of storm-scale modeling, would have contributed to a National Weather Service goal to improve severe thunderstorm warning lead time from an average of 18 minutes in 2000 to as much as 2 hours by 2025; and tornado warning lead time from an average of 12 minutes in 2000 to as much as 1 hour by 2025[1].

Today's warnings are essentially "nowcasts" that are based on observations of events and extrapolation. To significantly extend the warning lead times will require accurate forecasts of severe weather events prior to their occurrence. This cannot be done without observing the 4-dimensional distribution of water vapor, the fuel for thunderstorms, on the scale of individual thunderstorm cells. Large variations in atmospheric water vapor occur on scales of 10 km in the horizontal, 1 km in the vertical, and tens of minutes in the temporal scale. The HES sounder was planned to provide a 4-dimensional picture of moisture with the temporal, spatial, and vertical resolution necessary to forecast individual thunderstorms accurately. It was expected to be capable of detecting the initiation of instability by observing the moisture flux, resulting in much longer lead times and supporting storm scale forecasting. There is no current satellite capability to observe moisture flux at a resolution comparable to the size of individual thunderstorms. Data from advanced sounders on polar-orbiting satellites lack the temporal coverage needed for storm-scale models. Other data sources, such as radar, wind profilers, aircraft reports, and Global Positioning System Meteorological sensor (GPS-Met) networks lack the spatial and vertical resolution needed to adequately monitor the pre-storm environment. Significant lead time improvements will likely be delayed until an advanced geostationary sounder capability is available over the United States.

Also, the presence of low-level temperature inversions can play a key role in the development or suppression of severe thunderstorms. A strong low-level inversion can totally suppress convective development, while a weak to moderate inversion can promote strong thunderstorm development by allowing the build up of fuel (water vapor) in the lower atmosphere until there is enough energy for a sudden explosive breakup of the inversion and thunderstorm development. A high-spectral resolution sounder such as HES is required to detect the evolution of low-level inversions. There is no current observing system capability to detect the evolution of low-level inversions at the necessary spatial resolution.

Finally, large variations in surface emissivity over land make satellite retrievals of temperature and moisture profiles difficult. Most severe thunderstorms occur over land.

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[1] NOAA's National Weather Service Science and Technology Infusion Plan 2004.

High-spectral resolution sounding instruments will show the variations in surface emissivity necessary for accurate temperature and moisture profiles and their rapid temporal evolution in the pre-thunderstorm environment. There is no current observing system capability to observe rapid temporal changes in surface emissivity at the necessary spatial resolution.

B. Coastal Waters Imaging Applications

The Coastal Waters Imager (CWI) capability planned for GOES-R was to have produced accurate quantitative ocean color products, including chlorophyll and turbidity, for areas along the U.S. East Coast (within 50 miles of shore) and in the 130 estuaries throughout the United States. These products, coupled with timely and precise *in situ* sampling, would provide NOAA with a capability to predict and monitor the growth, spread, severity, and duration of HABs and to monitor key parameters of the overall health of the coastal ecosystem. The CWI would have also provided enhanced temporal resolution and, for the first time, the ability to resolve the tidal component, crucial to understanding estuary and coastal systems. In addition, the CWI would have provided improved satellite data for use in determining optimal NOAA research cruise tracks. Satellite sensors used today, including the Sea-viewing Wide Field of view Sensor (SeaWiFS) and the Moderate Resolution Imaging Spectroradiometer (MODIS), are best suited for open-ocean, climate applications. They are also used to produce estimates of chlorophyll over the outer coastal regions, but they lack the spectral information, sampling frequency, and spatial resolution required to monitor many near-coastal areas where NOAA has management responsibilities, including Sanctuaries and other Marine Protected Areas and estuaries. In the future, the Visible/Infrared Imager/Radiometer Suite (VIIRS) on the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) will replace SeaWiFS and MODIS for continuity of open-ocean products as well as climate applications. VIIRS has similar characteristics to SeaWiFS and MODIS. Therefore, it does not address the coastal issues as described above.

The CWI capability on GOES-R would have allowed quantitative characterization of fundamental components of the Nation's estuaries for the first time. This instrument would have enabled NOAA to monitor change, including changes that occur during severe HAB-related mortality events. Current observing system capability allows us to resolve HABs that are no smaller than 10 square kilometers in size. The CWI would have been able to resolve blooms in the 1-2 square kilometer range.

Without a coastal waters imaging capability, we will continue with today's methods of relying on NPOESS/VIIRS and spot measurements from ships, autonomous underwater vehicles, and moorings to produce qualitative estimates of the health of our coastlines, bays, and estuaries. These capabilities will not provide the high-frequency, high spatial-resolution ocean color measurements, with sufficient spectral bands for separating biomass and turbidity, that are key to monitoring our coasts; advancing our understanding of the coastal ecosystems; and developing dynamic models of those systems. These measurements and models are essential for NOAA to meet its Mission Goals for coastal ecosystems and for climate assessments of coastal environments.